



Root Cause Analysis of Delays in the XYZ Toll Road Design and Construction Project Using the RCA Method

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Abstract

The XYZ Toll Road Construction Design and Construction Project Plan is a continuation of the Solo – Ngawi Toll Road which is part of the Trans Java Toll Road series and part of a program that was delayed due to the 1997 monetary crisis. The project faced a non-excusable, non-compensable delay, shifting handover from June 6, 2025, to November 30, 2026. This study identifies main delay factors, uncovers root causes, and offers solutions to minimize future delays. Employing a qualitative descriptive method with questionnaire data, it applies the Root Cause Analysis (RCA) method—including Pareto diagram, fishbone (*Ishikawa*) diagram, and 5 Whys—to pinpoint issues. Root causes include zero percent land acquisition at contract signing (causing phased handovers), impassable geographical conditions requiring road trajectory shifts, and ongoing financial closing by the owner/employer during implementation. Findings provide strategies and managerial implications to accelerate decision-making, reduce overlapping responsibilities, ensure design-to-construction information continuity, and integrate cost, quality, and time controls.

Keywords: Design and Build, Project Delays, RCA, fishbone, 5WHYS

Introduction

The construction industry has been considered one of the major industries that makes a great contribution to the economy and growth of a country. A project is a complex, non-routine venture limited by time, budget, resources, and performance specifications designed to meet customer needs. The problem of congestion continues to soar, the government is designing an alternative road that connects Surakarta to Yogyakarta. The XYZ Toll Road Construction Design and Construction Project Plan is a continuation of the Solo – Ngawi Toll Road which is part of the Trans Java Toll Road series and part of a program that was delayed due to the 1997 monetary crisis. The Presidential Regulation (Perpres) that regulates the implementation of the Solo-Yogyakarta toll road is Presidential Regulation Number 3 of 2016 concerning the Acceleration of the Implementation of National Strategic Projects, which was later amended to Presidential Regulation Number 58 of 2017.

This Presidential Regulation covers the construction of the Solo-Yogyakarta toll road infrastructure as part of the National Strategic Project (Hartono et al., 2021; Mulyani et al., 2025; Naufal & Husodo, 2022; Oetari & Isworo, 2024). Design and Construction Project The

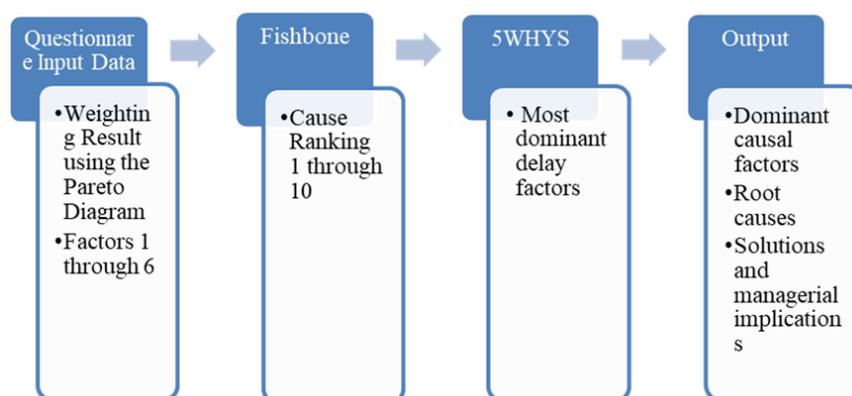
construction of toll roads here uses regular contracts with the payment of unit prices (Chen et al., 2018). The type of project contract here is different from the Toll Road Construction Design Project in general, because this project only has a basic design and there is no Final Engineering Plan (RTA) or commonly called Detail Engineering Design (DED), so to be able to start work can be done with the type of Design and Build contract.(Alhawatmeh O. S, 2023)(W.Lar, 2006)(Sri Rahayu, 2024)

Delays are a common problem in construction projects around the world. Completing the project on time is essential to avoid additional costs, disputes between owners and contractors, and project cancellations (Bajjou & Chafi, 2020; Fakunle & Fashina, 2020). Some construction projects often experience delays due to their complexity. Execution time is an important factor in project management in addition to cost and quality. In a project, there must be a certain time limit (Goswami & Urminsky, 2020). The demands of the project must be completed on time is a challenge in itself. There are several factors in the implementation time of a project that can be an obstacle to achieving targets (Elraaid et al., 2024; Jawad & Ledwith, 2021). For this reason, it is necessary to conduct a study on the factors of project implementation time and ways to maximize project implementation time, so that there will be no delays.(Bektas S, 2021)

The difference between this study and the previous research is that this study uses the research object in the Design and Build Project with the Root Cause Analysis (RCA) method to find out the root of the problem that causes delays. This Root Cause Analysis (RCA) method has advantages including being systematic and in-depth, can be used in dispute analysis, suitable for analysis of delays, work accidents, and building defects. The application of the RCA method is already widespread, using common sense techniques that can produce a systematic, measurable and documented approach to the identification, understanding, and resolution of the underlying causes. In the RCA method often uses (Voley, 2008)Pareto chart to find out the weight, fishbone diagram to group the various potential causes of the problem into categories (e.g.: Human, Machine, Method, Material, Environment, or other causal factors) and after the potential cause is identified then proceed to stage 5WHYS to trace the root cause of a problem.

Delays occurred in this project, resulting in a delay in the delivery of the work planned for June 6, 2025 to November 30, 2026. The objectives to be achieved in this study are to identify the main factors that cause delays in the XYZ Toll Road Construction Design Project, analyze the root of the delay factors in the XYZ Toll Road Construction Design Project, provide inputs and solutions that can be applied to minimize delays in this project.

Method



Picture 1. Research Process Flow
(Source: Author)

Research variables are factors that become indicators of a research. The research variables were obtained from literature studies (books, journals) and from interviews with relevant sources where the factors used as variables were those that influenced the design project. The variables that will be taken for this study are adopted from several studies as follows:

Table 1. Research Variables

No	Factors and Causes of Project Delays
Factor 1: Planning and scheduling aspects	
1	Lack of proper planning and scheduling
2	Changes in design/work details at the time of implementation
3	Changes in the scope of work at the time of implementation
4	The process of making working drawings by contractors
5	The process of requesting and approving a working image by the employer/owner takes a long time
6	Misunderstanding of the rules for making working drawings
7	There are many (often) additional jobs
8	Request for changes to completed work
Factor 2: Competency Management	
1	Low productivity of detailed engineering design completion
2	Subcontractors/suppliers are incompetent in meeting the specifications in the set design
3	Inexperienced consultants
4	Incompetent site management and supervision
5	Slow in making decisions related to design selection
6	Implementation of new construction methodologies, sequences, and approaches
Factor 3: Communication and Coordination Management	
1	Inadequate coordination with other parties
2	Ineffective communication with other parties
3	Too many change orders by the employer/owner
4	Slow to agree on coverage
5	Slow to implement inspection and testing of materials/mockups for designs
Factor 4: Financial Management	
1	Financial/funding issues, payment of work progress, cash flow, budgeting (related to employer/owner)
2	The contractor does not pay or postpone the work that has been completed
3	The contractor's financial problems so that the term to the planning consultant is too late
4	Consultant financial problems
5	Changes in government policy and leadership that can hinder the design process
6	Compensation payments
Factor 5: Job inspection/control/evaluation management	
1	Inadequate skilled workforce of planning consultants
2	Construction errors due to working drawings from planning consultants
3	Improper or inadequate selection of plants and equipment
4	The lack of materials that have been selected in the design so that they have to replace the design with available materials
5	Land acquisition, ownership
Factor 6: Miscellaneous	
1	Strike of employer/contractor/planning consultant/supervisory consultant employee
2	The work environment of the employer/contractor/planning consultant/supervisory consultant is not conducive
3	There is a change in central/local government policies that has an impact on changes in trajectories

(Source) (Junaid Tariq, 2023)(Yap J. B. H, 2021)(Proboyo, 1999)

Purposive sampling was the technique used to select data sources based on specific

considerations related to the study's population characteristics, which researchers already knew. This approach had several advantages: it aligned samples directly with research objectives for easy achievement; it proved efficient in the sampling process; it effectively explored anthropological situations through an intuitive method; it suited primary data sources; and it contributed effectively to studies with limited data or populations. Researchers found this technique straightforward to implement.

The questionnaire was distributed to stakeholders of the XYZ Toll Road Construction Design Project in the context of establishing a decision hierarchy. The selection of respondents was based on the consideration that the respondents were directly related to the construction process and decision-making in the XYZ Toll Road Construction Design and Construction Project as many as 32 people with the following list of respondents:(Sugiyono, 2018)

Table 2 List of Respondents

No	Respondent's Position	Sum
1	Owner/Employer	1 Person
2	Staff Owner/Employer	1 Person
3	Contractor Managerial Level	7 People
4	Contractor Manager Project Level	7 People
5	Contractor Staff Level	8 People
6	Planning Consultant	4 People
7	Supervisory Consultant	3 People
8	BPJT Staff	1 Person

(Source: Author)

After knowing the risk factor variables, in this study a tool was used to carry out the research, in the form of a questionnaire. The scale used in the preparation of the questionnaire is an interval from 1-5.

Table 3 Questionnaire Scale

NO	DESCRIPTION	INFORMATION	SCORE
1	Very Undecisive	STM	1
2	Not Determinant	CE	2
3	Neutral/Ignorant	N/TT	3
4	Determine	M	4
5	Decisive	BC	5

(Source: Author)

Root Cause Analysis (RCA) Method

Method Root Cause Analysis (RCA) is an analysis method used to identify the root cause of an undesirable problem or event. By understanding the root cause and the problem, RCA aims to find the underlying cause of a problem so that the solution applied can prevent the recurrence of the problem in the future. Root Cause Analysis is a systematic approach that focuses on the fundamental causes of a problem, not just its surface symptoms.(Dukes, 2009). Root Cause Analysis is one of the methods that functions to identify and analyze failure of a system and correct the failure. (Yanto, 2018)

Pareto diagram

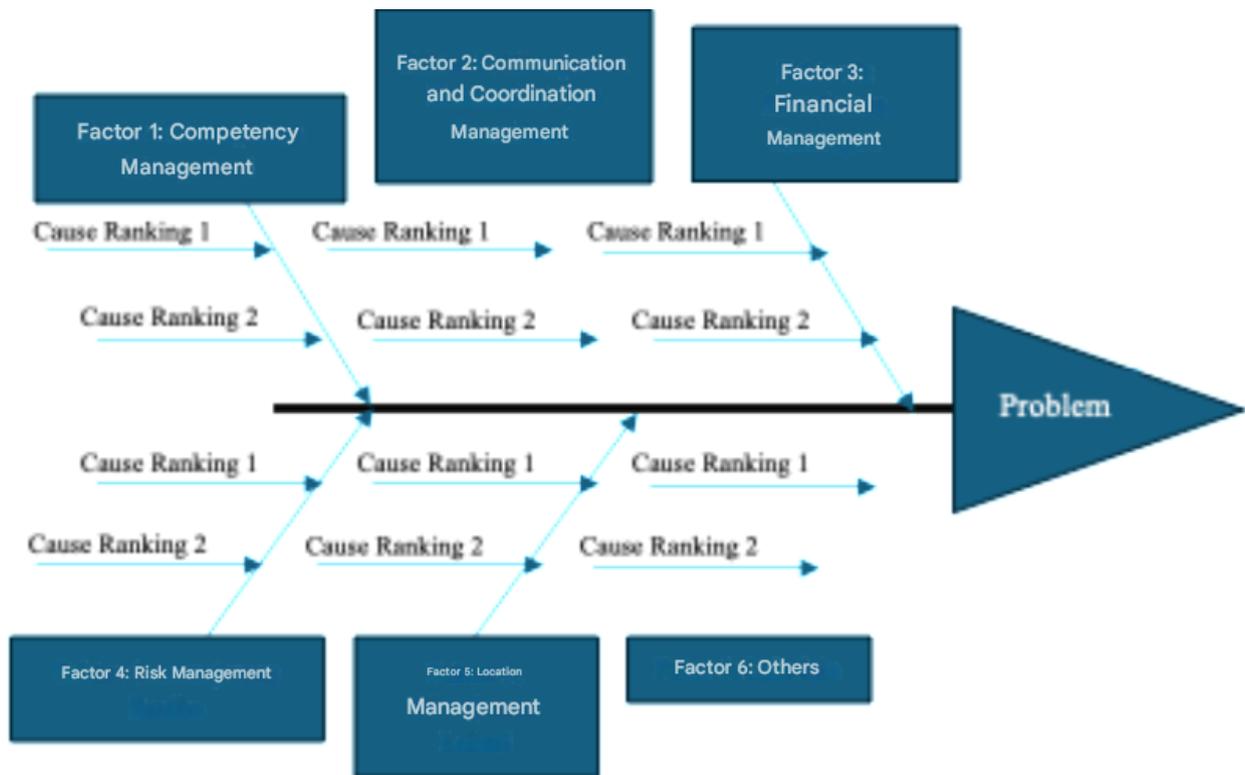
The inventor of the Pareto principle was Vilfredo Pareto, an Italian economist, in the late 19th century. The Pareto diagram is a new evolutionary concept that has its roots in modern management styles, which have been applied in various developed countries. Pareto charts help

us identify the problems that have the most impact, so we can focus on solving the things that really matter first. As a Pareto quality control tool can be used to determine the relative frequency and order of importance of the problems at hand, or the factors that cause the problems that occur, the diagram also focuses attention on critical and important issues through ranking the problems that occur, or the causes of the problems in a significant form. Here's a brief description of calculating weights and sorting them from largest to lowest:(Rabou, 2017)(Gaspersz, 1997)

1. Sort the largest to lowest frequencies
2. Calculating cumulative frequencies
 $FK = \text{The sum of each frequency} \dots \dots \dots (1)$
3. Calculate cumulative percentage = x 100% $\dots \dots \dots (2) \frac{\text{Cumulative Frequency}}{\text{Total Frequency}}$

Fishbone Diagram

The concept of causal diagrams originated in 1943 when Dr. Karou Ishikawa explained to engineers how factors could be sorted in an organized manner. In the process of analyzing the factors and risks faced, the use of the Fishbone method can also be applied, where this method is useful for analyzing various triggering factors for the occurrence of a result of a certain obstacle, it can be said as one of the processes of analyzing the triggering factors for the occurrence of an effect. An effect occurs due to the influence of certain factors. The results of the questionnaire that have been conducted by Pareto then include the dominant factors in (Ishikawa., 1991)(S. S. Utami, 2018)fishbone diagram as follows:

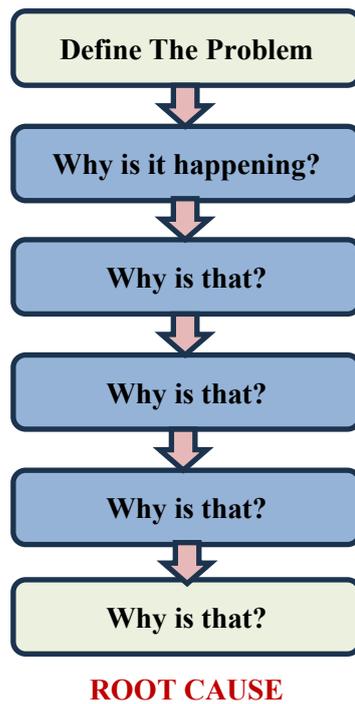


Picture 1. Fishbone Diagram (Source: IAPSM Blog)

5WHYS

Analysis 5 Whys is a structured approach in which asking the question of why repeatedly to understand the cause of the problem, and to come up with effective corrective actions to reduce the incident, and prevent the occurrence of accidents from happening again. At this stage, the

results obtained will continue to be processed at the fishbone diagram stage. (Kuswardana A, 2017) Analysis 5 Whys is one of the effective efforts to identify root cause or the cause of a problem. This method forces analysts to think about root cause of an issue. In this way, the analysis can identify more in-depth problems. Main strengths Analysis 5 Whys is to prevent teams from being satisfied with solutions that only solve problems on the surface and will not fix the problem in the long run. Meanwhile, the following are the stages in conducting 5WHYS analysis: 1) Select one of the 'cause' items in the Company related to quality. Make sure all teams have a common understanding of the item (why 1). 2) Teams can start asking questions. The first question usually starts with: 'why did this item happen?' (why 2). 3) Select one of the reasons from the answer to the question in step 2. Move on to the next question: 'Why does this happen?' Continue the process until why 5 and the team feels that the issue has reached the root cause.



Picture 2 Process flow 5WHYS

After determining the factors causing the delay, the root cause of the problem is then searched using the root cause analysis type 5 whys. The search for the root cause of the delay problem is as follows:

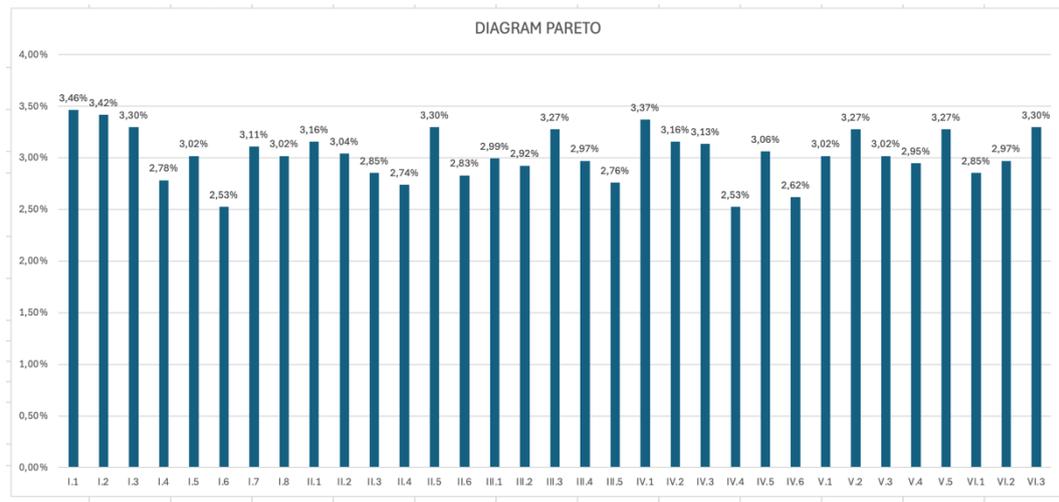
Table 4. RCA Analysis 5Whys Project Delay Factors Source: Root of the problem search results (2022)

Failure	WHY1	WHY2	WHY3	WHY4	WHY5
The most dominant Delay Factor					

Results and Discussion

This study uses a qualitative descriptive method, the formation of a decision hierarchy is carried out by distributing questionnaires to stakeholders of the XYZ Toll Road Construction Design Project. The selection of respondents is based on the consideration that the respondents are directly related to the construction process and decision-making in the construction of the

XYZ Toll Road. The selected respondents totaled 32 people who understood the problem and were directly involved in solving problems in the project. The selection of respondents here uses *the purposive sampling* technique.



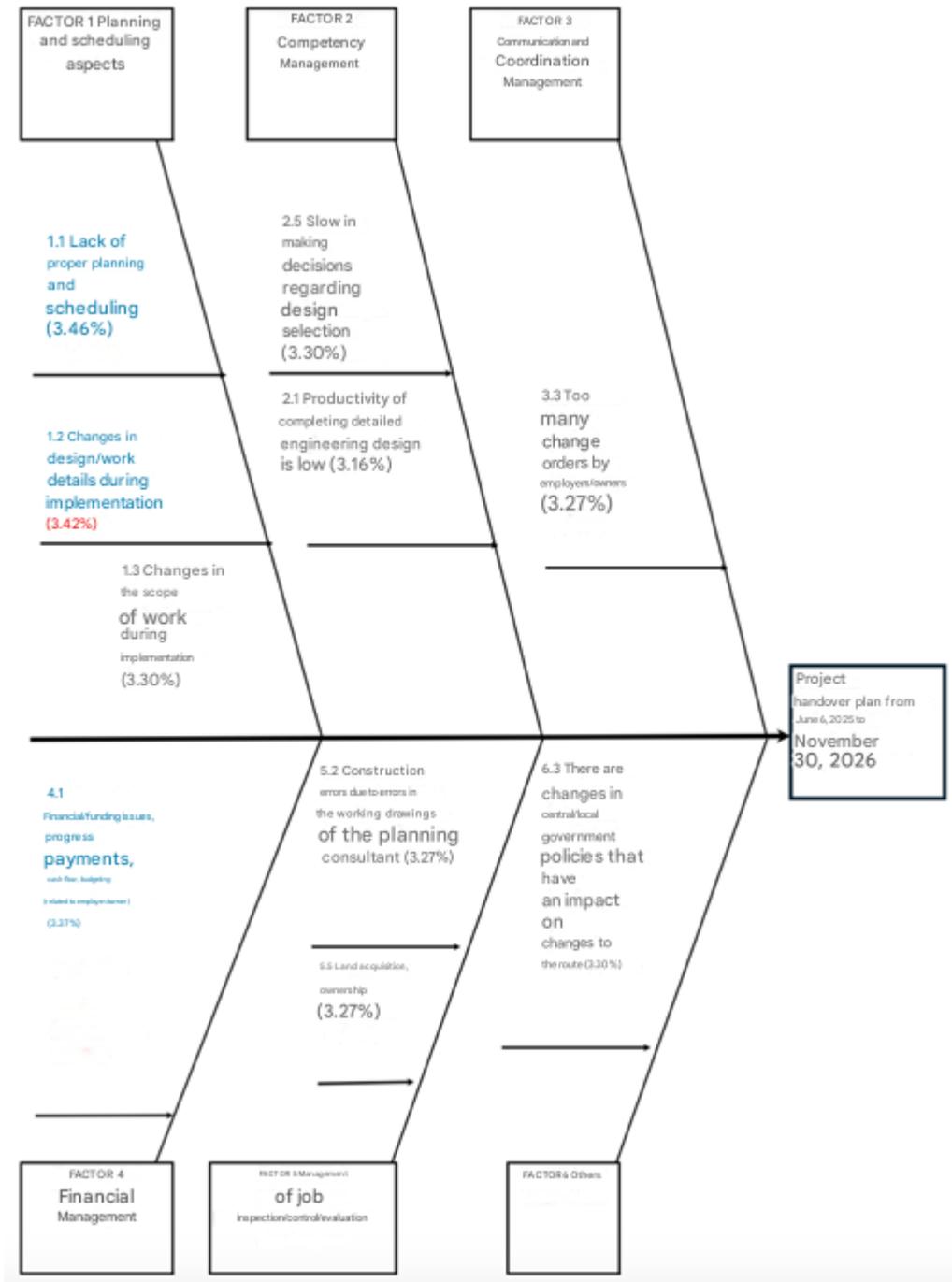
Picture 3. Pareto chart of the results of the weighting questionnaire (Source: Author)

From the results of weighting all factors, the 10 highest order and these factors have been approved as the factors causing delays in the XYZ Toll Road Construction Design Project are as follows:

Table 5. TOP 10 factors of delay in the XYZ Toll Road Construction Design Project (source: author)

NO	FACTOR	WEIGHT
1	1.1 Lack of proper planning and scheduling	3,46%
2	1.2 Changes in design/work details at the time of implementation	3,42%
3	4.1 Financial/funding issues, payment of work progress, cash flow, budgeting (related to employers/owners)	3,37%
4	1.3 Changes in the scope of work at the time of implementation	3,30%
5	2.5 Slow in making decisions related to design selection	3,30%
6	6.3 There is a change in central/local government policy that has an impact on the change of trase	3,30%
7	3.3 Too many change orders by the employer/owner	3,27%
8	5.2 Construction errors due to working drawings from planning consultants	3,27%
9	5.5 Land acquisition, ownership	3,27%
10	2.1 Low design detail completion productivity	3,16%

From the TOP 10 table of delay factors in the XYZ Toll Road Construction Design and Construction Project are included in the fishbone (Ishikawa) diagram according to the cluster of each factor as follows:



Picture 4. Ishikawa Diagram (Source: Author)

After determining the priority, there are 3 dominant factors that are the cause of delays, then a search is carried out for the root cause of the problem using the root cause analysis type 5 whys. The search for the root of the problem of the factors causing the delay is as follows:

Table 6. Root Cause Analysis of 5WHYS Lack of proper planning and scheduling

Factors Causing Delays	Lack of proper planning and scheduling
WHY 1	The realization of work is not in accordance with the work plan that has been set
WHY 2	Waiting for a working image
WHY 3	The existing working drawings are only partially according to the available land
WHY 4	Waiting for partial land handover
WHY 5	At the time the contract is signed, 0% land acquisition is carried out so that the land handover is carried out in stages during the implementation

(source: author)

The root of the problem of 5WHYS lack of proper planning and scheduling is that at the time the contract is signed, a 0% land acquisition is signed, so that the land handover is carried out in stages during the implementation.

Table 7. Analysis of the root of the problem 5WHYS Changes in design/details of work at the time of implementation

Factors	Causing	Changes in design/work details at the time of implementation
Delays		
WHY 1		Adjustment of working drawings to actual conditions in the field
WHY 2		Technical calculations of the design have not yet been done
WHY 3		Pending additional investigations
WHY 4		There are changes in the layout and trajectory of the road
WHY 5		There are some locations that have geographical conditions that are not possible to pass through

(source: author)

The root of the problem of 5WHYS changes in the design/details of the work at the time of implementation is that there are several locations that have geographical conditions that are not possible to pass so it is necessary to shift the road trajectory.

Table 8. Analysis of the root of the problem 5WHYS Financial/funding problems, payment of work progress, cash flow, budgeting (related to employers/owners)

Factors	Causing	Financial/funding issues, payment of work progress, cash flow, budgeting (related to employer/owner)
Delays		
WHY 1		Payment foreman, sub kont, vendor must queue
WHY 2		Negative project cashflow
WHY 3		At the beginning of the payment project with the CPF (Contractor Pre Financing) system.
WHY 4		Term cannot be processed pending the availability of funds
WHY 5		When the project is running, <i>the owner/employer</i> is still doing the <i>financial closing process</i>

(source: author)

The root of the problem of 5WHYS problems with finance/funding, payment of work progress, cash flow, budgeting (related to the employer/owner) is that when the project is running, the owner/employer is still doing the financial closing process.

Conclusion

The study concluded that the XYZ Toll Road Construction Design Project experienced excusable, non-compensable delays, shifting submission from June 6, 2025, to November 30, 2026. Primary factors included inadequate planning and scheduling, design changes during implementation, and employer-related financial issues such as funding delays, progress payments, cash flow, and budgeting. Root causes were zero percent land acquisition at contract signing (necessitating phased handovers), impassable geographical conditions requiring road trajectory shifts, and ongoing financial closing by the owner/employer. Recommended solutions involved ensuring minimum land acquisition progress before tender, balanced contract clauses for joint delay resolutions, risk-based design optimization adaptable to field conditions, disciplined change management, and mitigation of late payment risks by factoring in Interest During Construction (IDC) costs. For future research, comparative analyses of RCA methods

across multiple toll road projects could validate these findings and refine mitigation strategies.

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